Publishable Summary for 21SCP01 DCC2GO
Supporting the implementation of Digital Calibration Certificates in the European metrology community

Overview

Replacement of paper-based calibration certificates with their digital counterparts Digital Calibration Certificates (DCCs) is vital for the digital transformation of many European industrial and legal metrology sectors. However, not all members of the European metrology community have access to the knowledge and capabilities needed for the implementation of DCCs. This project has addressed this issue by supporting the implementation of DCCs within the European metrology community, through the coordinated production and sharing of training material. In particular this project has focused on the benefit to smaller and emerging National Metrology Institutes (NMIs) and Designated Institutes (DIs) referred to in this project as the SEND community. This capacity building is needed to support a harmonised level of basic DCC knowledge and capabilities throughout the European metrology community as well as to address the needs of the wide range of stakeholders with an interest in DCCs.

Need

The drive towards digital business in Europe is a high priority initiative originating from the European Commission ([1],[2]). The first and one of the highest priority steps for the metrology community is to replace paper-based calibration certificates with their digital counterparts, DCCs. Several DCC types (including machine readable DCCs) are currently under development within a few larger European metrology institutions (e.g. PTB and the Swiss NMI METAS). However, support for the digital transformation and implementation of DCCs is needed for NMIs and DIs outside of this small group and in particular for the SEND community. Currently there is a lack of information freely available to the rest of the general European metrology community on DCCs, and how to use them. In addition, there is a lack of training material tailored to the needs of the wide range of stakeholders with an interest in DCCs.

The urgent need for support for the implementation of DCCs in the European metrology community has been highlighted by key stakeholders and at events within the European metrology community: e.g.

- International Conference on Weights and Measures (CIPM) who's "The international System of Units (SI) in FAIR digital data" workshop in 2021 had 600 international participants who indicated DCCs as a priority. Indeed, the work of an earlier project 17IND02 SmartCom led to the foundation of the CIPM Task Group on the 'Digital-SI' in October 2019.

- EURAMET Technical Committees (e.g. TC-T and TC-M) and the Technical Committee for Interdisciplinary Metrology's (TC-IM) projects 1448 'Development of Digital Calibration Certificates', TC-IM 1449 'Research data management and the European Open Science Cloud' and TC-IM working group 'Metrology for Digital Transformation' (WG M4D) (DCCs were on 3 EURAMET TC agendas in 2021 and DCC training material was ranked a number one priority);

- PTB's International DCC workshop in 2020 had 900 participants, of which 17 % NMIs have started implementing DCCs and 65 % were planning to start;

- calibration laboratories, for example a survey by Aalto in 2021 of 273 participants, showed that 65 % had no information on DCCs, but that 20 % intended to start using DCCs in next two years.

Furthermore in 2022 the international metrology community intends to make the joint development of a 'Digital-SI' a key objective through their vote on a resolution for Digital Transformation based on the SI at the 27th General Conference on Weights and Measures. This means that the European metrology community will be looking to EURAMET to be the provider of the necessary training and guidance material for DCCs.

Report Status: PU Public

EMPIR

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

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Objectives

The overall goal of this project was to support the implementation of DCCs in the European metrology community with particular focus on the SEND community; whilst also addressing the needs of the wide range of stakeholders with an interest in DCCs. The project did this via the production and dissemination of training material and practical guidance material on the use of DCCs, which will cover all DCC types available during the lifetime of the project (e.g. machine readable, Extensible Markup Language (XML)-based, PDF/A DCCs).

The specific objectives of the project are:

1. To produce a DCC training compendium, that can be used by stakeholders with no prior knowledge of DCCs to gain basic knowledge on DCCs. The DCC training compendium will be suitable for a wide range of stakeholders with particular focus on the SEND community and should support a harmonised level of DCC knowledge within the European metrology community

2. To produce a DCC starter kit for DCC implementation, containing step-by-step guidance for the creation, practical implementation and secure delivery of temperature and pressure DCC. The DCC starter kit should be focussed on the SEND community and will consider the large number of calibration certificate types issued and their wide range of applications. The applicability of the DCC starter kit will be ensured by validation by project partners.

Results

The 2 main outputs from this project were (1) a DCC training compendium, and (2) a DCC starter kit. When creating this training material and practical guidance the project assumed that stakeholders have no prior knowledge of DCCs so that it is as useful as possible for all stakeholders with an interest in DCCs.

Both of the project's outputs were targeted primarily for the SEND community, therefore, input from the SEND community was vital for ensuring they were as best suited as possible. The project partners IMBiH, DFM and Metrosert played the role of the SEND community and provided feedback in the project. The DCC training compendium and DCC starter kit was developed to support the SEND community in the implementation of a range of DCC types and for a range of metrological quantities.

Further to this, the project's outputs were developed so they are freely available to stakeholders on open access platforms, such as the project website and open access repository zenodo. The project also designed the content for EURAMET's eLearning platform with the end target of the DCC training compendium and DCC starter kit being accepted and published by EURAMET so that they can eventually become the 'go to' sources of independent information on DCCs for the metrology community.

   1. To produce a DCC training compendium, that can be used by stakeholders with no prior knowledge of DCCs to gain basic knowledge on DCCs.

The project has produced a "Freely available, DCC training compendium of basic knowledge for stakeholders with no prior knowledge of DCCs, with particular focus on the SEND community and supporting a harmonised level of basic DCC knowledge within the European metrology community," which is available at https://zenodo.org/records/8199281

The training compendium consists of several sets of slides explaining the DCC to technical experts, management, and stakeholders of metrology organisations. The material is available for download for self-study.

In addition, recordings of presentations of the slides are available online at the DCC2GO webpage (https://ptb.de/dcc2go and the recordings include English subtitles). The entry point for initiating work with DCCs is facilitated by the inclusion of guidelines and materials offered in the DCC2GO starter kit (Objective 2). All materials, their descriptions, and recommendations for how to access them are listed in the following Table.

#	Document Description/Access	Target group
1	**Readme for the DCC2GO training compendium** The readme provides an overview of the materials made available for training on DCCs by the DCC2GO project and the target audience for whom they are intended. DOI 10.5281/zenodo.8199281	all
2	**Common information on Digital calibration Certificate** This set of slides builds the entry point for the training on DCCs for all members of NMIs, Dis, and their stakeholders. It provides basic information such as a definition of the meaning of DCCs, their benefits, and the initial aspects of starting to work with them. DOI 10.5281/zenodo.8199281	all
3	**Information for management at NMIs and DIs** This material comprises slides providing more details on DCCs from a management point of view. It discusses legal and regulatory aspects, as well as information on DCC harmonisation and phases for DCC implementation in an organisation. It is recommended to study material 2 (common information) before reading this material. DOI 10.5281/zenodo.8199281	management
4	**Information for technical staff at NMIs and DIs** This material for technical staff members working with DCCs provides a deep dive into the DCC implementation examples using the PDF/A-3 format and the XML format. The creation and use of DCCs are discussed in front of the lifecycle of measuring equipment and calibration services. The material contains information on early work with DCCs, advanced developments, and examples of IT requirements. It is recommended to study material 2 (common information) before reading this material. Material 6 (example for DCC creation) is suitable follow-on material to the technical information. DOI 10.5281/zenodo.8199281	technical experts
5	**Information for stakeholders** This material comprises slides that summarise the impact of DCCs aiming at stakeholders of NMIs and DIs. It includes the outline of the Proof-of-Concept implementation of DCCs in a calibration chain demonstrating the link across an NMI, accredited calibration laboratory and an end-user of calibration. It is recommended to study material 2 (common information) before reading this material. DOI 10.5281/zenodo.8199281	stakeholders
6	**Example for the creation of a Digital Calibration Certificate (DCC) in XML and PDF/A-3 for people who start working with DCCs** This suite of slides, data, and software provides an easy-to-follow step-by-step guideline allowing users to create and explore their first XML DCC and PDF/A-3 DCC examples based on temperature calibration data. It demonstrates a quick (and dirty) approach based on open-access software tools. It is recommended to study material 1 (common information) and 2 (technical information) before continuing to go through this example. DOI 10.5281/zenodo.8199718	technical experts
7	**Freely available and validated, Digital Calibration Certificates (DCC) starter kit for DCC implementation; containing step-by-step guidance for the creation, practical implementation and secure delivery of temperature and pressure DCCs** See Section 4 for further description. The starter kit includes guidelines with blueprints for further implementation of DCCs, extending the basic knowledge from material 3 (management information) and material 4 (technical information). Furthermore, it provides a comprehensive list of additional examples and tools available for working with DCCs. DOI 10.5281/zenodo.8199700	all

2. To produce a DCC starter kit for DCC implementation, containing step-by-step guidance for the creation, practical implementation and secure delivery of temperature and pressure DCC.

The project produced a "Freely available and validated, Digital Calibration Certificates (DCC) starter kit for DCC implementation; containing step-by-step guidance for the creation, practical implementation and secure delivery of temperature and pressure DCCs." which is available at https://zenodo.org/records/8199700

The DCC2GO starter kit consists of practical guidance for metrology institutes to enable them to start working with DCCs. It contains step-by-step guidance for the creation, practical implementation, and secure delivery of DCCs. Blueprints for workflows to introduce DCCs at an organisation have also been established. These workflows combine the experience obtained by the DCC2GO project members, which are all European

metrology organisations that have gone through the process of introducing DCCs in the past years. The DCC starter kit is a suite of guidelines containing the following documents:

Guideline 1: How Metrology Institutes can start working with DCCs without any prior knowledge

This guideline addresses such issues as how to create a DCC, what IT infrastructure is needed and how to deal with the IT tools for handling the DCC.

Guideline 2: Collation of cryptographic tool information for DCC protection and validation

This guideline focuses on aspects of protection and secure submission of DCCs. It comprises different types of mechanisms for securing the content of DCCs such as digital signatures.

Table of DCC related resources

This table provides a broader collection of tools and documentation for DCCs that is openly available today. Background information is provided to users who start working with DCCs to allow faster access to relevant tools and information beyond the basic knowledge and training from DCC2GO.

Examples: https://zenodo.org/records/8199718

This suit of slides, data, and software provides an easy-to-follow step-by-step guideline allowing users to create and explore their first XML DCC and PDF/A-3 DCC example based on temperature calibration data. It demonstrates a quick (and dirty) approach based open access software tools.

Impact

A project webpage was created by PTB, that provides public access to the outcomes of the project as well as a point of contact for stakeholders who are interested in DCCs.

The project was presented at the 3rd international DCC conference (2023), and the video of this presentation was uploaded to the project webpage.

The SCP project plan was presented at the EURAMET TC-IM annual meeting in 2022 and an update on the current status of the project was presented at this year's TC-IM annual meeting in March 2023.

Metrosert made a presentation of DCC2GO outcomes at Euramet BoD Working Group for Capacity Building meeting that was held from 5th to 6th of October in Skopje, North Macedonia.

PTB gave a presentation on "How to start working with digital calibration certificates." At the annual meeting conference of TC-M in Brussels in September 2023. The conference participants were also informed on the outputs of the (DCC2GO) project. In the round table session on "Digitalization in metrology," conference participants shared their experiences with digitization in metrology in Japan, New Zealand, Colombia, Great Britain, Germany, Canada, and Bosnia and Herzegovina.

Finally, the outcomes of the DCC2GO project were presented to the EURAMET working groups TC-IM 1448 "Development of digital calibration certificates" and TC-IM M4D "Working group on metrology for digital transformation".

Early impact on user communities

The early outputs of the project i.e. it's DCC training compendium (Objective 1) and DCC starter kit (Objective 2) were targeted at the European metrology and SEND communities. Within the SEND community the project has supported the development of capacity for digital transformation and will support the implementation of DCCs and their delivery to customers. In particular, the DCC training compendium will help to provide a harmonised level of basic DCC knowledge across the wider European metrology community and the project's DCC starter kit will help to provide a validated step-by-step guidance for the practical implementation and secure delivery of temperature and pressure DCCs. This will help to enable the SEND community to gain sufficient knowledge of the infrastructure (e.g. IT requirements, software, investment) needed to deliver DCCs and to evaluate their capability to extend the DCCs from temperature and pressure (the two fields specifically addressed in this project) to other metrological areas relevant for their calibration stakeholders.

In addition to the DCC training compendium and DCC starter kit the project will also produce presentations

which include a comprehensive overview of DCCs and the results from the project. This will also be made freely available to the metrology community via the project's website and zenodo in order to help to harmonise DCC knowledge across Europe.

Longer-term economic, social and environmental impacts

DCCs provide an essential first step towards digital transformation in the metrology community. Knowledge gained in creating DCCs can be used to start the long-term process of evolving internal procedures within NMIs and DIs and the extended metrology community towards digital ways of working.

The process of evolving current metrological procedures into digital ways of working will generate the need for new tools (e.g. software) to manage, deliver and analyse the output from DCC generation and in the longer-term new employment opportunities in the metrological and scientific communities.

The use of DCCs together with future digital ways of working will also support the transition towards more efficient science and industry. For example, the cessation of paper-based calibration certificates will lead to less waste and support more energy efficient solutions for the economy and the environment.

Project start date and duration:	01 April 2022, 18 months
Coordinator: Anke Keidel, *PTB* Tel: +49 30 3481 9410 E-mail: anke.keidel@ptb.de Project website address: https://ptb.de/dcc2go	
SCP Funded Partners: 1. PTB, Germany 2. DFM, Denmark 3. DTI, Denmark 4. IMBiH, Bosnia and Herzegovina 5. Metrosert, Estonia 6. VTT, Finland	